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ABSTRACT

The effects of sentence imitation and picture verification on the recall of subsequent digits were studied. Stimuli consisted of 20 sentences, each sentence followed by a string of five digit names, and five structural types of sentences were presented. Subjects were instructed to listen to the sentence and digit string and then either immediately repeat the whole sequence or to indicate comprehension of the sentence by pointing to an appropriate picture and then to repeat the digit string. It was found that across all five sentence types digit recall was superior in the picture verification condition. There is a clear and consistent indication that the act of vocal repetition of a sentence provides a greater degree of interference in the digit recall than a simple verification of comprehension. The absence of sentence-type ordering suggests that the effect of sentence complexity on digit recall must be assigned to the regeneration phase of the imitation task. (SW)

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THE EFFECTS OF SENTENCE IMITATION AND PICTURE VERIFICATION ON THE RECALL OF SUBSEQUENT DIGITS

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Summary

Since the initial work of Savin and Perchonock in 1965, psycholinguists have investigated sentence complexity by asking subjects to repeat sentences followed by lists of unrelated items. The early work was a strong factor in the establishment of the "kernel + tag" theory of sentence storage. More recent studies by Scholes and his associates (Scholes, Heilman, and Rasbury, 1975; Scholes, Rasbury, Scholes, and Dowling, 1976; Heilman, Scholes, and Watson, 1976) established that the recall of the sentence was best treated as a interference task in that the increasing syntactic complexity of a sentence increases the interference, causing the span for the recall of subsequent lists to decrease.

The present study further refines the "interference" theory in that the degree of interference can be assigned to the sentence reproduction phase of the recall task. In addition, inspection of the serial position data for the recall of subsequent lists in this study reinforces the earlier claims concerning the separability of the sentential and list component of the recall paradigm.

Introduction and Literature Review

A classical approach to the study of the psychological complexity of various types of sentence structures has been the immediate recall of sentences followed by strings of digits or lists of unrelated words. This technique was first explored by Savin and Perchonok (1965) who reported that the recall of the subsequent list decreased as sentence complexity increased. Their interpretation of these results was that the amount of short-term memory (STM) required by the sentence could be quantified by the number of items from the subsequent list (of words, in their case) which could be correctly recalled. Further, their data suggested that the number of transformations which a sentence had undergone in its deep-to-surface structure derivation directly contributed to the STM load of the sentence. For example, after a simple, active, affirmative declarative sentence, 5.27 additional words could be accurately recalled while after the passive counterparts of such sentences, only 4.55 additional words could be recalled.

Various facets of this original work have been challenged in a number of subsequent studies, among them: Boakes and Lodwick (1971), Epstein (1969), Glucksberg and Danks (1969), Mathews (1968), and Wright (1968).

Scholes, Heilman, and Rasbury (1975) analyzed the serial position curves of digit recall to claim that the preceding sentences did not "occupy

space in STM" but rather that the comprehension and regeneration of the sentence constituted an interference task in the digit recall. Heilman, Scholes and Watson (1976) report the results of the application of this technique to Broca's and conduction aphasics.

Developmental aspects of the sentence-plus-digits-recall format (hereafter, #S#TM) were investigated in a study by Scholes, Rasbury, Scholes, and Dowling (1976). Using a Wechsler-type format (increasing the quantity of digits in a string) to establish digit span, seven-, ten-, and twenty-year-olds were tested with digits only, noun phrase plus digits, intransitive sentences (e.g., the man is smiling) plus digit strings, and transitive sentences (e.g., the man is hitting the girl) plus digit strings. An increase in digit span for increasing age was seen.

It is clear from the work of Scholes and his associates that the sentence imitation part of a #S#STM task involves the comprehension and regeneration (i.e., the act of producing the original) of the given sentence. This is shown most clearly by the fact that there is a strong primacy effect in the digit recall (if the sentence and the digit string both occupy space in a STM buffer, then the first digit of the string is not the first thing to be recalled and should not show a primacy effect).

There have not, to date, been any studies which compared the effects of sentence imitation and sentence comprehension on the recall of digit strings. We have, therefore, employed the #S#STM format in two conditions: one in which subjects repeat the stimulus, and one in which Ss indicate comprehension of the sentence by picture verification and then repeat the digit string. Whatever differences appear in correctness of digit recall and/or serial position analysis between the two conditions will indicate the effects on STM of the variation in the two sentence response tasks. Further, following the reasoning of Scholes, et al. (1975) that sentence imitation is a process of comprehension and regeneration, any variations between the two conditions should be due only to the mode of verification of comprehension; i.e., verification by spoken recapitulation or by pointing to an appropriate visual representation of the events denoted.

Methods

Stimuli

Stimuli consisted of twenty sentences, each sentence followed by a string of five digit names. The sentences consisted of four instances of each of five structural types: 1) simple active affirmative declarative (the man is hitting the woman, the dog is chasing the bird); 2) the BE passive counterparts of the sentences in 1) (The bird is being chased by the dog); 3) the GET passives of the basic sentences (the bird is getting chased by the dog); 4) conjoined pairs of SAAD sentences (the dog is chasing the bird and the bird is wearing a collar); and 5) relativized version of the sentences in 4) (the dog is chasing the bird that is wearing a collar). These five types of sentences are abbreviated as SA, BP, GP, CA, and RA; respectively.

Digits used were the numbers 1 through 9. Each sentence was followed by a string of five unordered digits.

Experimenters

Students in an introductory psycholinguistics class served as experimenters. There were 70 students, most of them female. Any possible experimenter effects on the results are assumed to be randomly distributed due to the large number of experimenters and the absence of any selectional criteria. Each E tested ten subjects.

Subjects

Subjects for the study were chosen by the experimenters from among their own acquaintances and relatives. The only restriction imposed was that the subjects be native speakers of English. There were 200 subjects in the picture verification condition and 175 subjects in the imitation condition. All subjects were over 18 years of age.

Procedure

Es presented the twenty stimuli to subjects individually. A single randomization was used for all Ss. Ss were instructed to listen to the sentence and digit string and then either immediately repeat the whole sequence (condition 1) or to indicate comprehension of the sentence by pointing to an appropriate picture and then to repeat the digit string (condition PV-picture verification).

The picture array used for the PV condition is shown in Figure 1.

Es were instructed to present the sentences in a normal speaking tone and to read the digits in a paced fashion of approximately one digit each second.

No other constraints were placed on the experimental procedure.

Results

Sentence Errors

Errors on sentence imitation and picture verification are treated in terms of the five sentence types. An error in the PV condition indicates that a picture was selected which was not the one conforming to the reading of the sentence. For sentence types SA, GP, and BP two of the four available pictures were correct and the chance rate is thus 50%; for sentence types CA and RA only one of the four is correct and the chance rate is thus 25%.

For the imitation condition, errors were considered in terms of major lexical items only. Subject's memory for articles and other "function" words is poor in general (Scholes et al, in preparation) and are ignored here. Data on sentence performance are indicated in Table 1.

Digit Recall

Overall digit recall as a function of sentence types is shown for the 1 and PV conditions in Table 2.

Digit recall in terms of serial position of the digits is shown within and across conditions in Figures 2 through 8.

No statistical analyses were performed on these data due to the fact that none of the claims made in the discussion below require measures of variance or significance.

Discussion

As indicated above, the differences in performance on digit recall for the Imitation and PV conditions is taken as a measure of the effect of the task variation. Both imitation and picture verification involve understanding the sentence and only the responses differ.

Across all five sentence types digit recall is much superior in the picture verification condition; 94% correct to 77%. There is, then, a clear and consistent indication that the act of vocal repetition of a sentence provides a greater degree of interference in the digit recall than a simple verification of comprehension. Conversion of the percentages into mean number of digits correctly recalled yields 4.70 for picture verification and 3.85 for imitation. Thus, the imitation of the sentence appears to decrease the digit span by nearly one full unit.

Comparison of the sentence types in terms of digit span (Table 2) yields considerable new information. It may be noted first that the scores here are somewhat lower than those previously reported. Savin and Perchonock (using eight items, rather than our five) got mean scores of 5.27 for simple active and 4.55 for passive sentences. Scholes, Heilman, and Rasbury (using the method of increasing digit string length until Ss err on two consecutive strings) got the following scores: SA, 5.38; BP, 5.30; CA, 4.46; and RA, 4.07 (GP was not used). While the present scores are lower (due, no doubt, to the lower ceiling), the order is verified; i.e., from most to least difficult; RA-CA-BP(GP)-SA. This order of difficulty is not shown, however, in the digit recall for the picture verification condition. The absence of sentence-type ordering in this condition suggests that the effect of sentence complexity on digit recall must be assigned to the regeneration phase of the imitation task.

Figures 4-8 verify the earlier findings of Scholes et al. in showing strong primacy effects in the digit recall. This suggests that the sentences do not occupy space in STM in the sense of Savin and Perchonock, " . . . namely, the capacity of the entire memory - minus the number of items in the subsequent list recalled" (1965, p. 350). Further, these analyses show that the sentence regeneration depresses but does not change the shape of the serial position curves; i.e., its effect is to the whole digit recall task, not just to some component of it (e.g., the primacy or recency components).

Summary

Early research showed that sentence complexity had a direct and quantifiable effect on the recall of subsequent lists of unrelated items. It was thought that this effect was due to the amount of STM taken up by the propositions and transformations which comprise each sentence. It was later shown that while the quantifications could be replicated under a variety of conditions, the effects seen were not due to the STM space requirements of the sentence but rather due to the interference caused by the comprehension and regeneration of the sentence. In the present study, this theory is further refined so as to assign the sentence complexity effects to the regeneration phase of the sentence imitation.

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Table 1. Errors in sentence imitation and comprehension.

Sentence Type	Imitation (S=175)			Picture Verification (S=200)		
	N	Error	% Cor.	N	Error	% Cor.
SA	700	66	91	800	10	98
BP	700	79	89	800	24	97
GP	700	131	81	800	37	95
CA	700	179	74	800	42	94
RA	700	217	69	800	39	95

Table 2. Overall digit recall scores for each sentency type.

Sentence Type	Imitation			Picture Verification		
	Errors	% Cor.	Mean DS	Errors	% Cor.	Mean DS
SA	475	86	4.30	187	95	4.75
BP	608	83	4.15	193	95	4.75
GP	724	79	3.95	317	92	4.60
CA	1026	70	3.50	214	95	4.75
RA	1165	67	3.35	283	95	4.65

Figure 1.

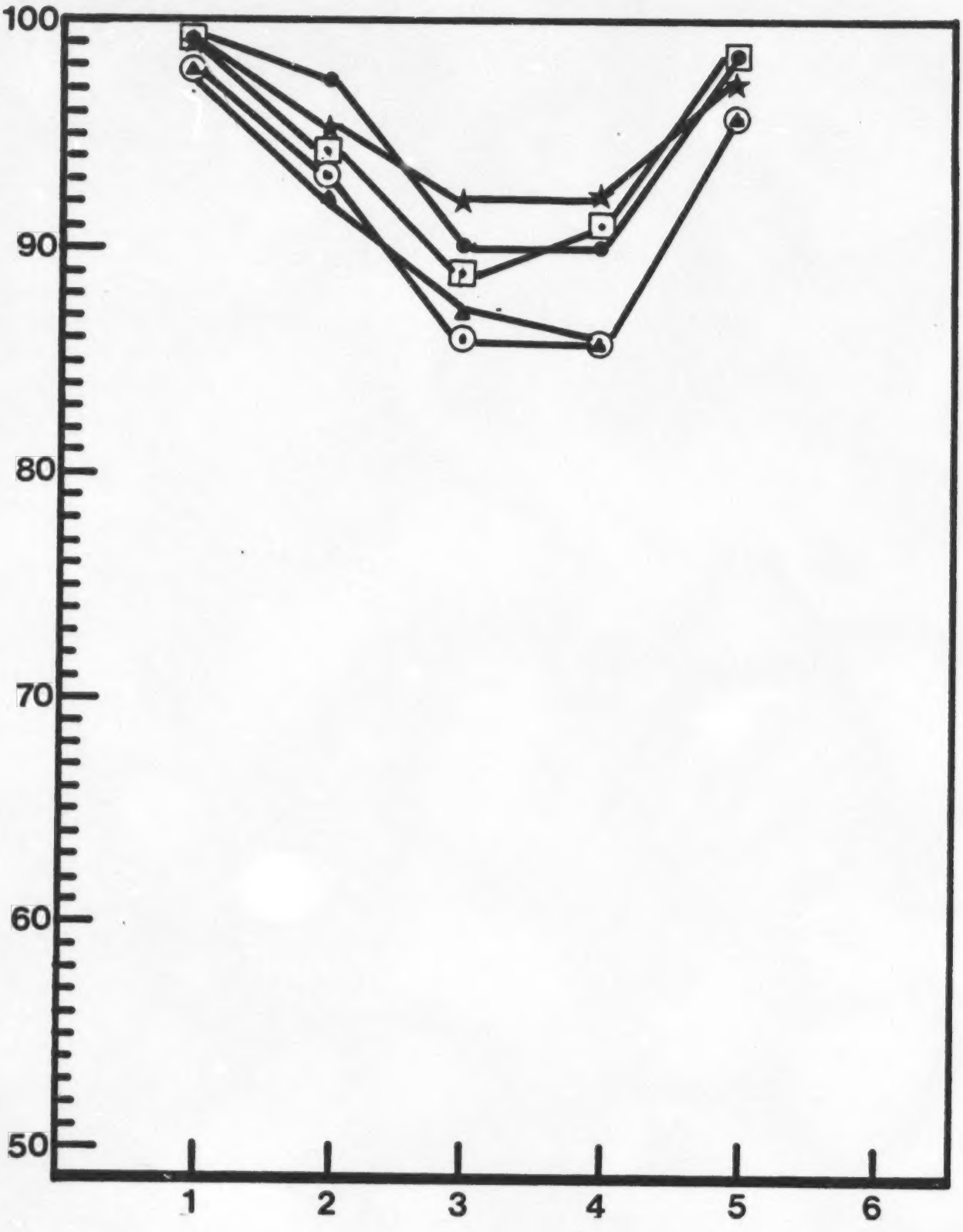

Figure 2 11

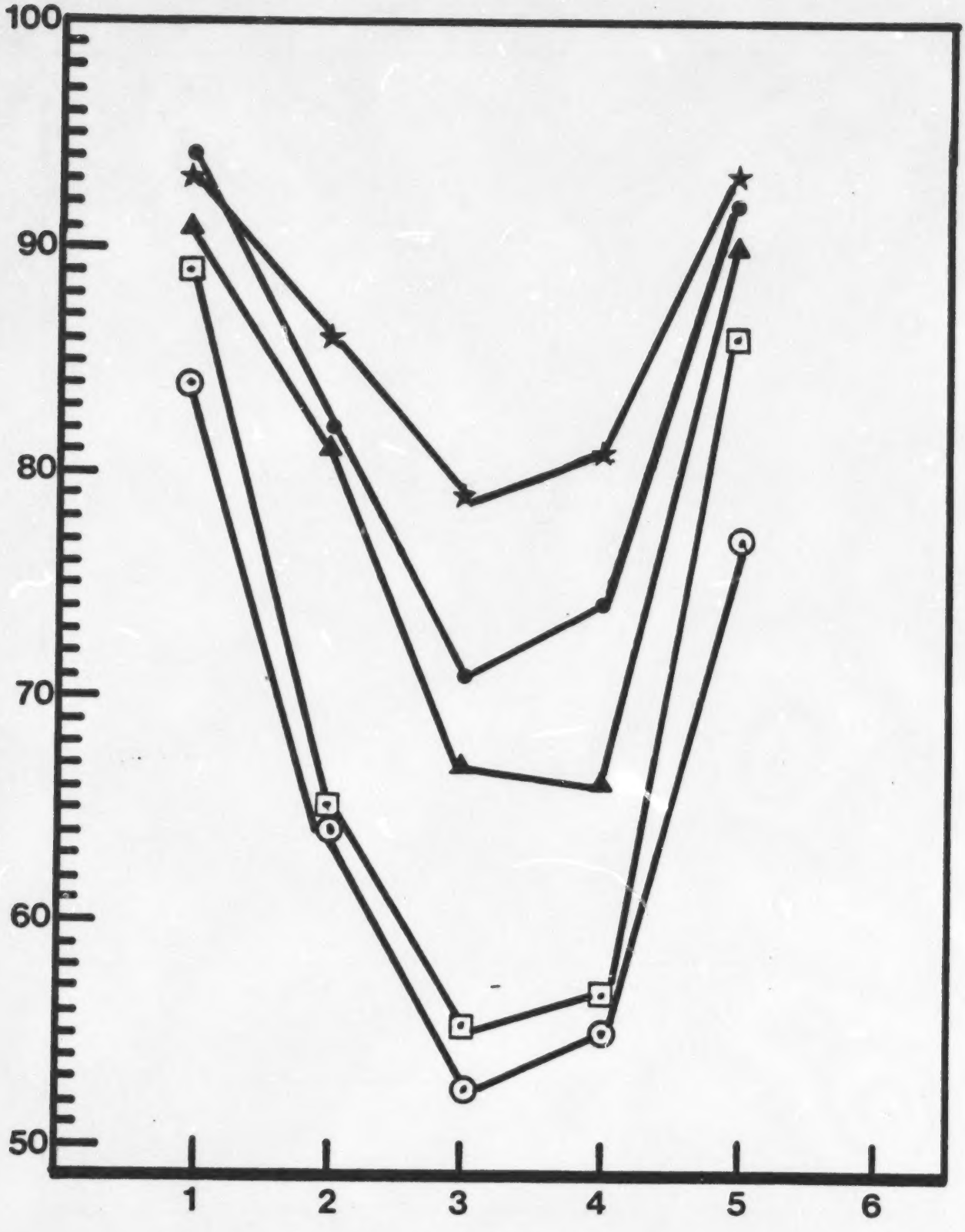

Figure 3

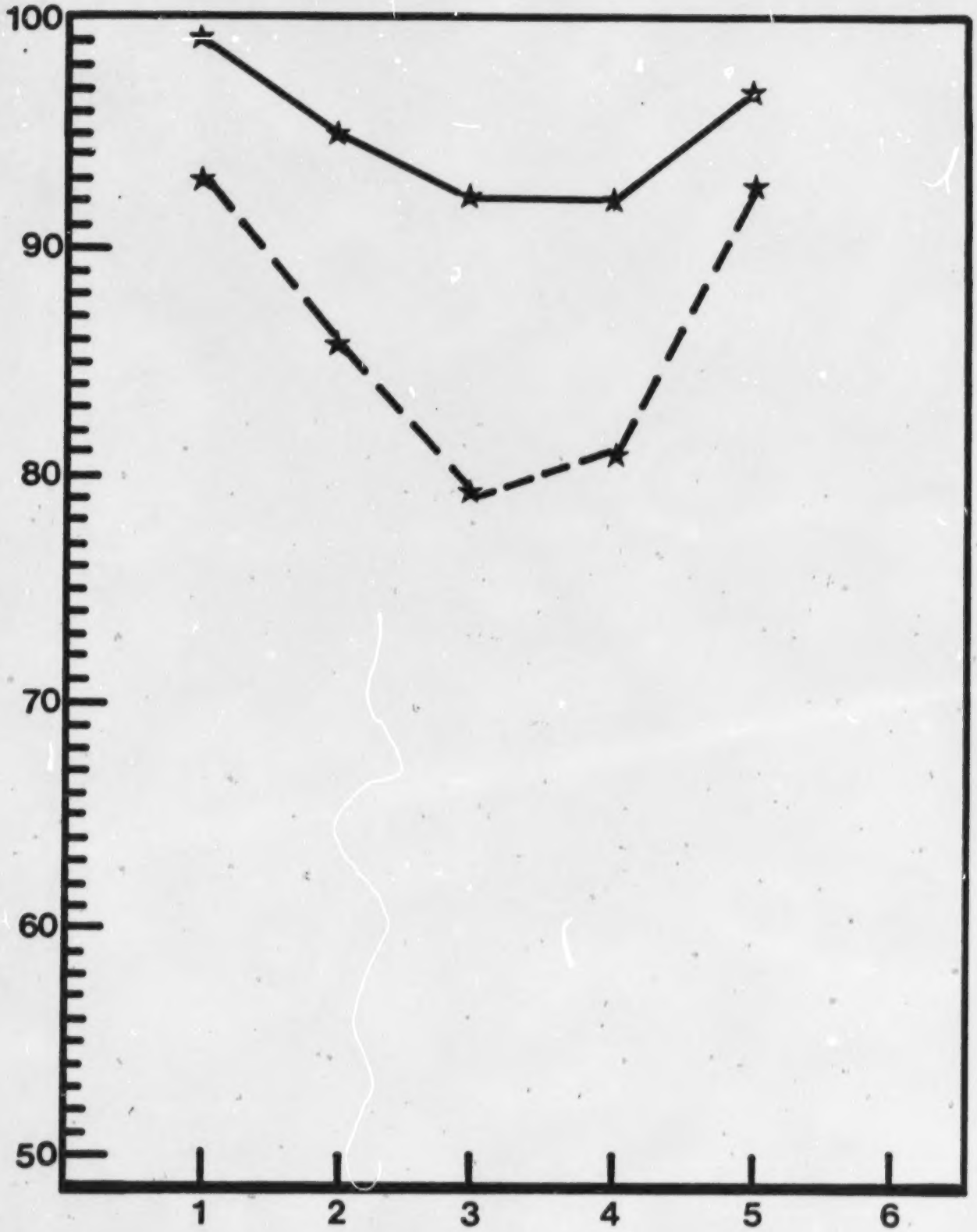

Figure 4[13]

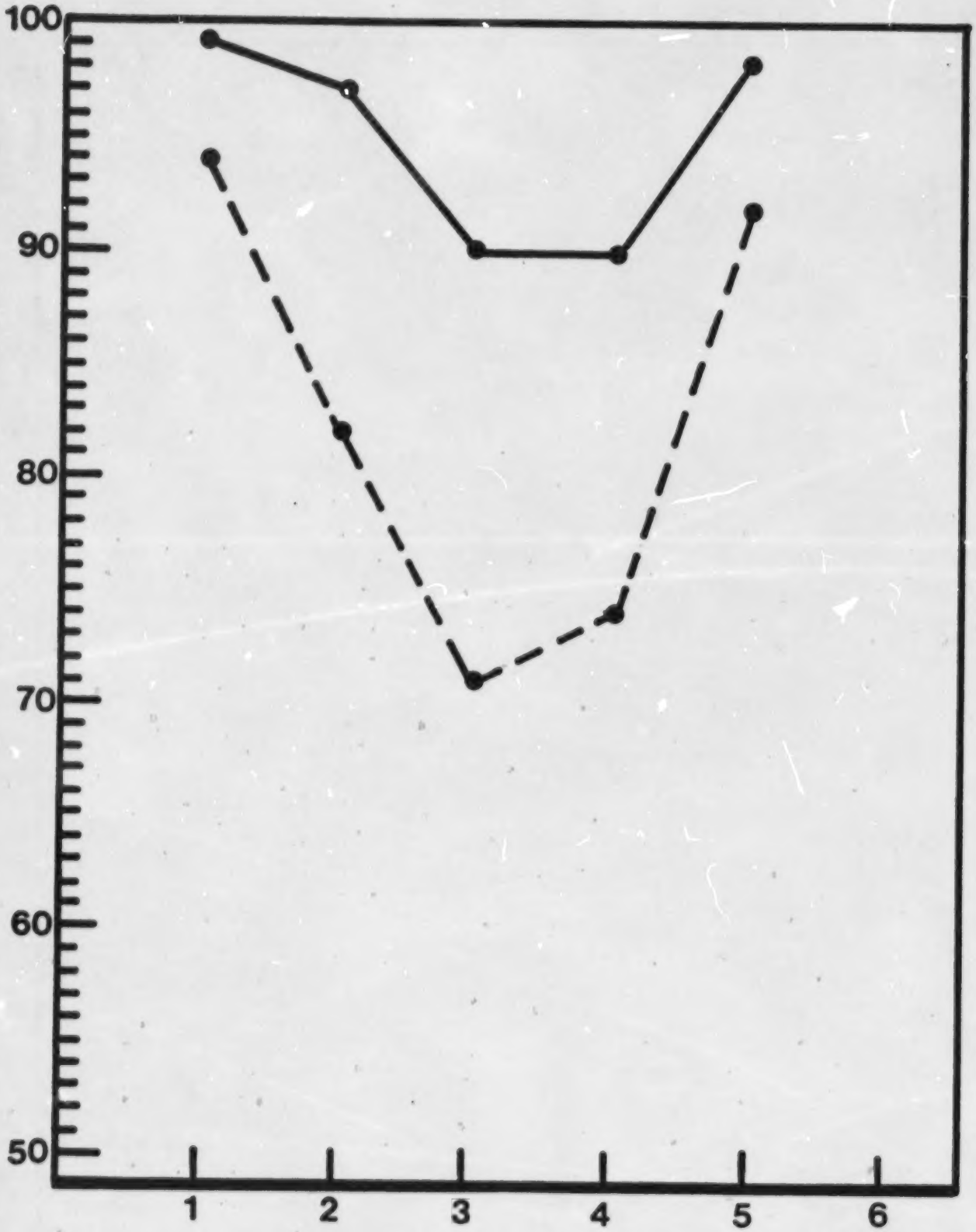

Figure 5

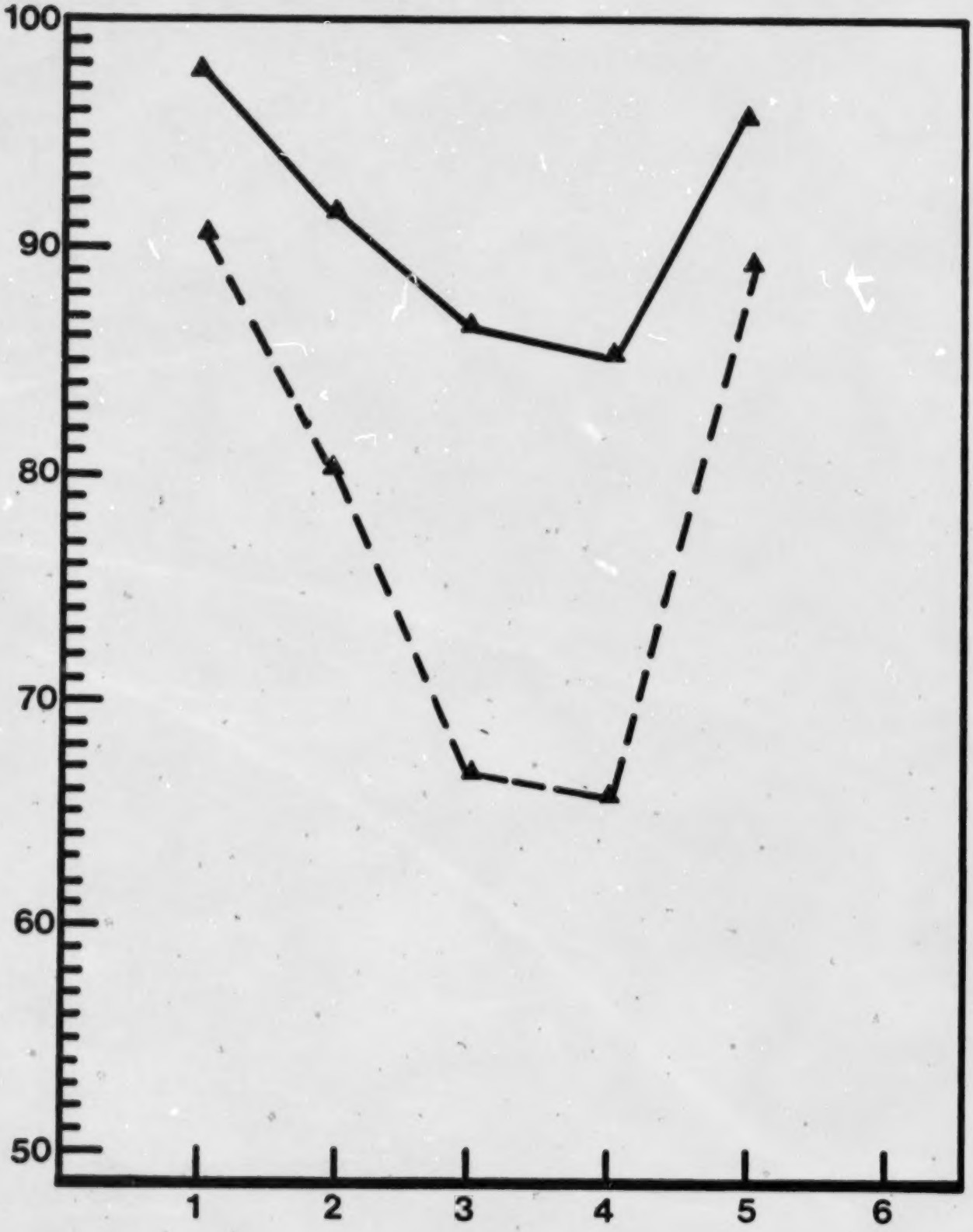

Figure 6

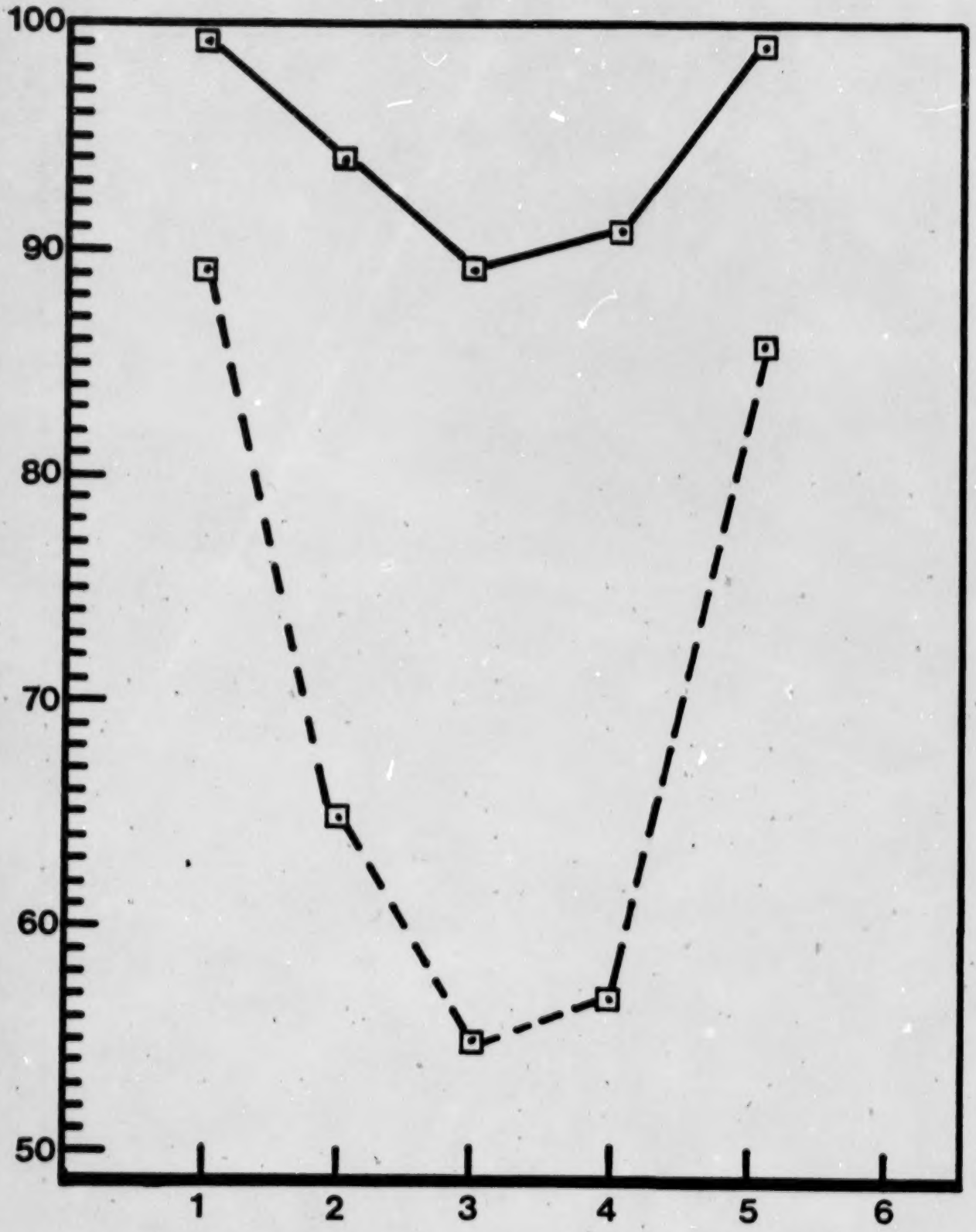

Figure 7

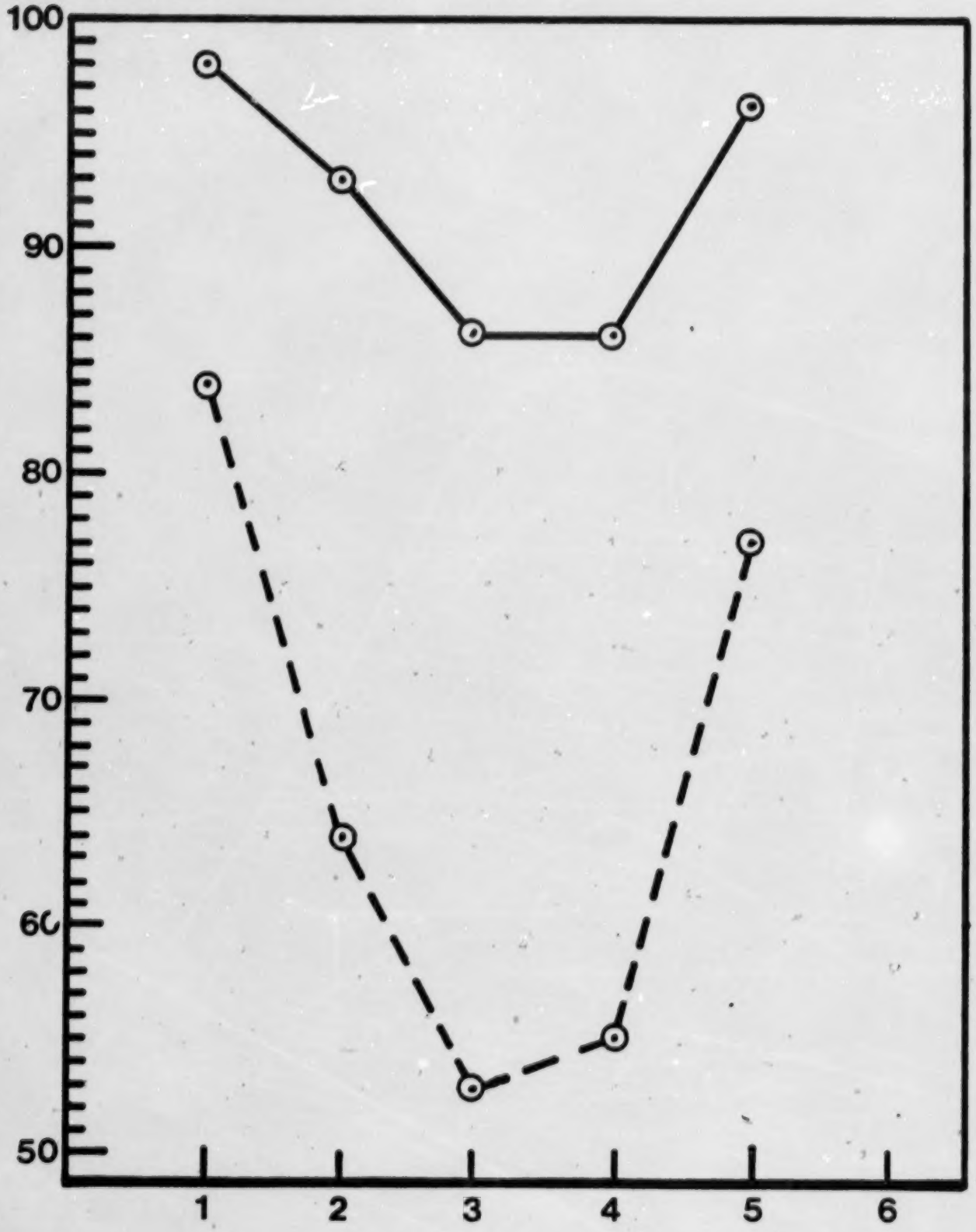

Figure 8

Figure Legends

Figure 1. Sample array of pictures for the Picture Verification Condition.

Figure 2. Serial position curve for digit recall by sentence type for the picture verification condition.

★ SA ⊡ CA ⊙ RA ▲ GP • BP

Figure 3. Serial position curve for digit recall by sentence type for the imitation condition.

★ SA ⊡ CA ⊙ RA ▲ GP • BP

Figure 4. Serial position curves for simple active sentences.

—— Picture verification — — Imitation

Figure 5. Serial position curves for Be Passive sentences.

—— Picture verification — — Imitation

Figure 6. Serial position curves for Get Passive sentences.

—— Picture verification — — Imitation

Figure 7. Serial position curves for compound active sentences.

—— Picture verification — — Imitation

Figure 8. Serial position curves for relativized active sentences.

—— Picture verification — — Imitation